Notes

On the Behaviour and Flight Patterns of the Neotropical Butterfly, *Anartia fatima* Fabricius (Nymphalinae)

Local movements by insects must allow efficient use of different habitat components, especially where areas for mating, adult foraging and larval development do not coincide precisely (e.g. Gilbert, L. E. & M. C. Singer. 1975. Butterfly ecology. Ann. Rev. Ecol. Syst. 6:365-397). This paper reports the flight behaviour of *Anartia fatima*.

A. fatima flies over many types of cleared terrain in Central America. A study, from 21 to 24 July 1979, was made at 1250 m in Chiriqui Province of the Republic of Panama, and at sea level in Corcovado National Park in Costa Rica, 3 October 1981, both during the wet season. The Chiriqui colony occupied about 1.5 ha of a coffee plantation, the butterflies frequenting the grassy and weedy areas between rows of bushes. At Corcovado they occurred in a scrubby pasture, grazed by ponies, and surrounded by second growth scrub.

Females were followed and their behaviour noted. During half hour periods, the number of flowers visited, eggs laid and interactions with other *A. fatima* were recorded. The number of flights, and their distances, were recorded (measured by pacing or with a ruler; many flights shorter than 0.2 m were not measured to avoid disturbance). The direction of each flight for females (at Corcovado) was assigned to one of 8 equal sectors (each of 45°). For analysis, butterflies were counted as flying straight on if successive flight directions fell into the same or one of the two adjacent sectors, and as changing direction if into any of the five other sectors.

All flights were assigned to one of three categories: foraging flight during and between adult feeding periods, oviposition flight during egg laying periods and displacement flight, comprising all remaining flights (see Table 1).

1. Foraging flight. Many short flights (80% unmeasured), whilst flitting between flowers.

2. Displacement flight. Long flights (all measured) used to commute between foraging, resting and oviposition areas. The flight was directed (more flights straight

Table 1. Flight characteristics of female *Anartia fatima*

Flight Type	Number of Measured Flights	Distance per Measured Flight in Metres Mean	S.D.	Number of Unmeasured Flights	Proportion of Flights Straight on
Foraging	41	1.6	1.7	176	28/47 (60%)
Displacement	58	8.4	9.2	0	38/45 (84%)
Oviposition	121	1.7	*	0	—

*: S.D. not estimable as not all flights measured separately—range of 15 flights (including longest) 0.15-20.0 m.

on than whilst foraging $X^2 = 5.92$; $p < 0.05$). Displacement flight was faster than the other two categorized, and at steady height (1.0 to 1.5 m) above the ground for long distances.

3. Oviposition flight. Many intermediate length flights (all measured). This flight partly consisted of agitated fluttering, landing for just a second or two on many occasions. Flight high relative to length (up and down).

Mate location and rejection.—Male *A. fatima* fly actively in search of mates (patrolling sensu Scott, J. A., 1974; Mate-locating behavior of butterflies. Amer. Midl. Nat. 91:103-117), which it has been suggested conforms to a zigzag pattern (Emmel, T. C., 1972; Mate selection and balanced polymorphisms in the tropical nymphalid butterfly, *Anartia fatima*. Evolution 26:96-107). At Corcovado four males were followed. Whilst flying (20 out of 53 minutes), they encountered 33 other males and 12 females, a faster encounter rate than when settled, when 22 other males and no females were intercepted in 33 minutes.

Females often rejected males by closing their wings sharply and positioning their undersides at right angles to the approaching suitors, thus obscuring the pale band on their upper surfaces, which Emmel (1972) showed to be attractive to males. In 9 of 10 cases when a male intercepted a flying female, she landed and then adopted the rejection posture, on the tenth occasion the female flew on, and after a brief chase the male left. More commonly in other species the female's wings are spread, and usually vibrated, and the abdomen raised to preclude copulation. Female *Mellicta athalia* Rott. (a European Nymphalid) initially snap their wings shut when males or other large insects fly past, only adopting the raised abdomen posture if the male comes very close (C.D.T. pers. obs.). When female *M. athalia* close their wings, they become less visible and may avoid detection by unwanted males and potential predators. *A. fatima* appears to have developed this simple avoidance into a distinct rejection posture. Scott, J. A. (1973; The mating of butterflies. J. Res. Lepid. 11:99-127) recognised various rejection postures, but data for *A. fatima* was not included.

Behaviour sequence and flight patterns.—At Chiriqui, a single female was followed from 10.05 to 13.16 (Fig. 1). Having fed on a patch of flowers for 50 minutes, she moved away from them onto grass and subsequently to a coffee bush, on which she reted. After resting she resumed activity and started to oviposit in a more shaded area, laying about 75 eggs, before being lost at 13.16. By this time it has started to drizzle, the rain becoming heavy by 13.30, after which no more activity by any *A. fatima* was seen.

Two females were followed at Crcovado. Both started by feeding, followed by a period of considerable movement, one of them then resting, having moved from where it was nectaring. Unfortunately, both butterflies were lost before engaging in other behaviour, flying out of the study field over the surrounding scrub, but probably would have started to oviposit as both had become agitated (see oviposition flight) and one had commenced crawling on the ground. At Chiriqui the female laid eggs low on the vegetation and litter, having first crawled over it.

The frequency of courtships by males increased towards the end of the feeding period, after which the Chiriqui female moved out of the flower-rich area (where most males were) and the number of courtships decreased. At Corcovado, where nectar sources were more evenly distributed, females did not escape the attentions of males so effectively when they moved from where they had been feeding. At San

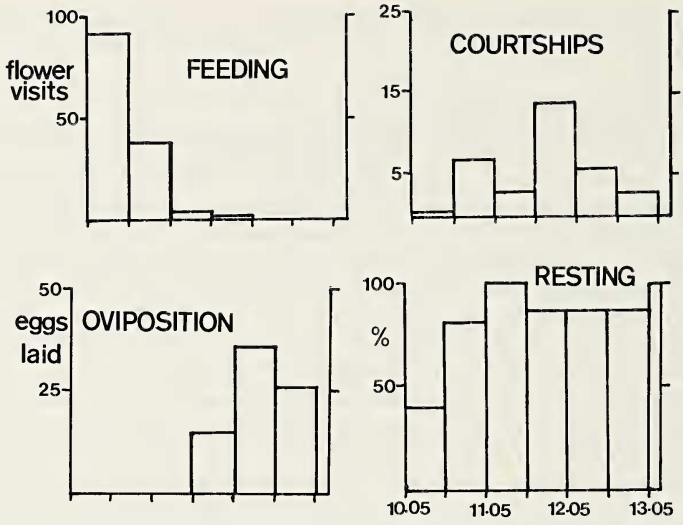

Fig. 1. Behaviour sequence of a female *Anartia fatima*, showing the number of flowers visited (n = 134), the number of courtship attempts by males (n = 34), the number of eggs laid (n = 75) and the percentage of minutes in any half hour when resting was observed.

Vito in Costa Rica (similar altitude and climate as Chiriqui site) Emmel (1972) found that male activity peaked mid to late morning.

Wicklund, C. (1977; Oviposition, feeding and spatial separation of breeding and foraging habitats in a population of *Leptidea sinapis* Lepidoptera. Oikos 28:56-68) found that the pierid *L. sinapis* L. followed a sequence of feeding then ovipositing; the females were observed to feed on flowers in woodland and then to move out into a meadow to lay. Movements between adult feeding and larval development areas have also been described for *Euphydryas editha* Boisduval (Gilbert, L. E. & M. C. Singer, 1973; Dispersal and gene flow in a butterfly species. Amer. Nat. 107:58-72).

The displacement flight was longer and more straightened out than foraging flight, permitting travel between different habitat components, whereas foraging flight was appropriate to feeding in restricted flower patches. The behavioural sequence and flight patterns suggest that distinct responses to habitat components allow butterflies to utilize resources efficiently.

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